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Triadelphia acericola and *T. centroseptata* spp. nov., and a synopsis of the genus

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Abstract—A new hyphomycete species found during a collection of microfungi from plant debris and decaying wood in Connecticut, USA, is described and illustrated here as *Triadelphia acericola*. The new species produces four conidial forms: form (a), the predominant form, is cylindrical and 2-septate, with the apical septum covered by a wide dark band; form (b) is oblong or ellipsoidal and 1-septate; form (d) is clavate and pluriseptate, with the middle transverse septum covered by a dark band; and form (f) is globose. Literature on all published *Triadelphia* names is reviewed, and a comparative synopsis of the genus and a key to *Triadelphia* species are provided. "*Triadelphia centroseptata*" nom. inval. is validated by designation of a holotype, and *T. archontophoenicicola* nom. nov. is proposed to replace the illegitimate homonym, *T. australiensis* Joanne E. Taylor et al.

Key words—*Acer*, anamorph, nomenclature, pleomorphic, saprobe

Introduction

Triadelphia was erected by Shearer & Crane (1971) as a monotypic genus typified by *T. heterospora*. The generic concept of *Triadelphia* was originally described as: "Conidiogenous cells subspherical, subhyaline to dark colored, producing conidia from a very limited area at the apex. Conidia readily deciduous, leaving a pore when detached, cylindrical, rounded at the apex, rounded to slightly truncate at base, dark colored, and septate." (Shearer & Crane 1971). *Triadelphia heterospora* develops two different forms of conidia: 1) cylindrical and 2-septate and 2) broadly obclavate to ellipsoid and 4–7-septate;

both conidial forms have at least one septum covered by a dark band (Shearer & Crane 1971).

Hughes & Pirozynski (1973) transferred *Dicoccum inquinans* to *Triadelphia*. Maggi et al. (1978) described two new species: *T. loudetiae* and *T. pulvinata*. Constantinescu & Samson (1982), who studied herbarium specimens of *T. inquinans*, type specimens of *T. heterospora*, and ex-type cultures of *T. loudetiae* and *T. pulvinata,* found those species to be pleomorphic, developing 2–5 forms of conidia, and emended the generic description of *Triadelphia* to: "Conidiogenous cells arising from undifferentiated hyphae, hyaline or pale brown, flask-shaped, fusiform, cylindrical or clavate, solitary or agglomerated in sporodochium-like structures, mostly with determinate growth and producing one apical conidium. Conidia blastic, of at least 2 (sometimes 5) forms in every species: (a) cylindrical, brownish,1–2 septate; (b) clavate, dark brown, unispetate [sic]; (c & d) obclavate to acicular with a narrow long tip, hyaline or yellowish brown, multiseptate; (e) allantoid, hyaline or pale yellowish, 0–3-septate, sometimes also (f) obovate to broadly ellipsoidal, pale brown, unicellular." Constantinescu & Samson (1982) simultaneously described a new species, *T. romanica*, and transferred *Stemphyliomma alabamensis* to *Triadelphia*.

Kirk (1983) transferred *Sporidesmium uniseptatum* to *Triadelphia* based on conidiogenous cell morphology and conidial ontogeny and morphology, which were all similar to the previously published six *Triadelphia* species. Mercado Sierra & Castañeda-Ruiz (1983) published *T. stilboidea*, a synnematous species from Cuba, and Révay (1987) published *T. hungarica* from Hungary. Tzean & Chen (1989) described as new *T. diversa*; they also reviewed and compared eight *Triadelphia* species but did not include *T. stilboidea* or *T. hungarica* in their review and key.

Sutton (1989) described *Triadelphia australiensis*, a species with only one conidial form, although he acknowledged that all other *Triadelphia* species develop at least two forms of conidia. Matsushima (1989, 1995) described two new species, *T. queenslandica* and *T. synnematofera* (the second synnematous species in *Triadelphia*). Révay (1993) published her second new species, *T. morgoensis*, with a key to 12 species; she also noted that as *T. stilboidea* probably did not belong in *Triadelphia* due to its synnematous nature, she omitted *Triadelphia stilboidea* from her key.

Venkateshwarlu et al. (1997) added *T. centroseptata* to the genus. Manoharachary et al. (2001) described *T. corticola* as having two conidial "forms," which appear to represent the same form varying only in conidial width and shape: conidia in *T. corticola* share the same length, septation

characters, and conidiogenesis and belong to form (a) of Constantinescu & Samson (1982). The most recent species added to *Triadelphia* is *T. australiensis* Joanne E. Taylor et al. (Taylor & Hyde 2003). Of the eighteen species described in *Triadelphia,* "*T. centroseptata*" was invalidly published and is validated here.

Since the morphological characters and conidium ontogeny of our specimen collected in Windsor, Connecticut, cannot be ascribed to any previously described *Triadelphia* species, we propose it here as a new species, *T. acericola*.

Materials & methods

An undescribed hyphomycete was collected from a piece of inner bark of *Acer palmatum* during a collection of fungi from plant debris and decaying wood in a mixed forest, wood log piles, and a landscape garden at the Valley Laboratory, Windsor, CT, in June 2013. The specimen was placed in a paper bag and brought back to the laboratory. Isolation on to MEA and CMA was attempted in the same day. However, isolation was not successful. Therefore a small scalpel was used to remove fungal structures directly from the samples for morphological observation under an Olympus BX40 compound microscope. Conidiophores, conidia, and other fungal structures were mounted in 85% lactic acid or lacto-fuchsin (0.1 g acid fuchsin, 100 ml 85% lactic acid; Carmichael 1955). The fungal structures were microscopically observed and measured under Nomarski differential interference contrast optics. Photomicrographs were captured using an Olympus Microfire digital camera (Goleta, CA). Data of the fungal structure measurements were statistically analyzed using Microsoft Office Excel 2013 with 95% confidence interval of means. The results were presented as ranges and mean ± standard deviation as well as Q (ratio of conidial length/width).

Taxonomy

Triadelphia acericola D.W. Li, **sp. nov.** Figs 1, 2a

MycoBank MB813008

Differs from *Triadelphia heterospora*, *T. inquinans*, and *T. diversa* by not having conidial forms (c) and (e).

Type: USA, Connecticut, Windsor, 41°51′02″N 72°39′43″W, elevation 38 m, from wood of Japanese maple (*Acer palmatum* Thunb., *Sapindaceae*), 11 June 2013, De-Wei Li (**Holotype**, BPI 893194).

Etymology: epithet is named after the genus *Acer* on which the fungus was collected.

Colonies on natural substrate thinly diffuse, dark brown. Mycelium partly immersed and partly superficial, sparse, composed of colorless to pale brown, irregularly branched, smooth, septate hyphae. Conidiogenous cells monoblastic, small, 1-celled, smooth, ellipsoid, pale brown, 3 × 2.5 µm. Conidia apical, solitary, dry, pleomorphic, of four different forms (as categorized by Constantinescu & Samson, 1982): form (a) cylindrical, oblong, or clavate,

straight or slightly curved, smooth, thick-walled, light brown, (1–)2-septate, the apical septum covered with a dark band 2.1–4.3 μm thick, (11.5–)13.5–16 (–16.6) × (3.5–)4–5.5(–6) μm (mean = 14.5 ± 1.2 × 5 ± 0.6 μm, n = 33), Q = 2.2–4.1 (mean = 3.1), with rounded ends; form (b) oblong or ellipsoidal, smooth, pale brown, thick-walled, 6.5–11 × 3.5–4.5 μm, 1-septate at the middle or off center; form (d) clavate (incomplete), 17.5–19 × 6–7.5 μm, pluriseptate (often 4-septate), central cells pale brown to brown, with the middle transverse septum covered by a dark 2–2.5 μm wide band; smooth; end cells subhyaline to light brown, with truncate base; form (f) globose, subglobose, or ellipsoidal, pale brown to brown, unicellular, smooth, thick-walled, (4–)4.5–6(–6.5) × 4–4.5(–5) μm (mean = 5.1 ± 0.7 × 4.2 ± 0.3 μm, n = 12).

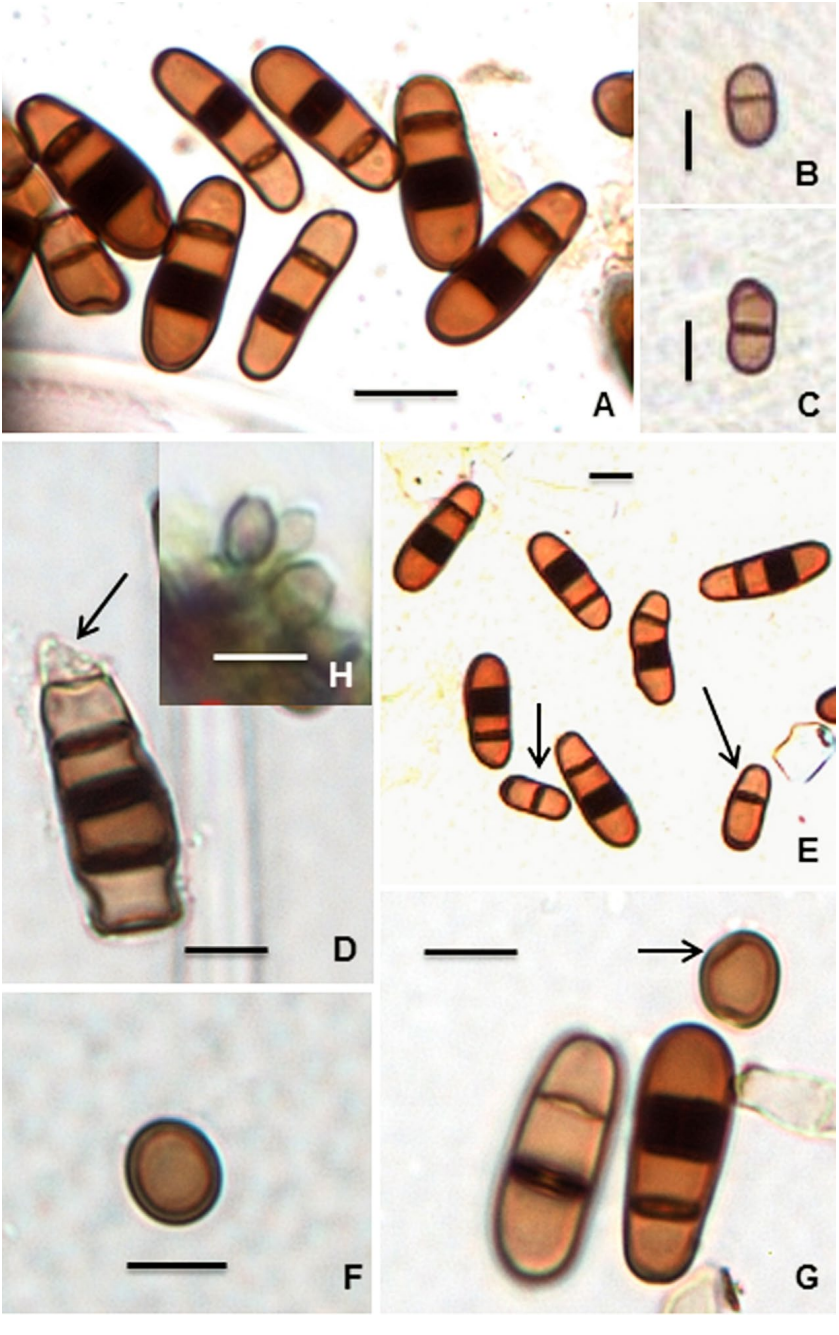
Note: There is a pore visible in the center of each septum and at the basal end of a conidium. The conidial forms used in this paper follow the six conidial forms categorized by Constantinescu & Samson (1982). In *Triadelphia acericola,* conidia of form (a) predominate, comprising over 90% of all conidia, with the three other forms (b, d, f) constituting <10%.

Very few intact conidiogenous cells were observed. It appeared that these conidiogenous cells collapsed once conidia became mature. Two apical cells of some mature conidia collapsed and even disintegrated, leaving only the basal cell. No intact form (d) conidia were present. Thus, the number of septa and size cited for form (d) conidia are approximations.

Conidiogenous cells were also not found in *T. inquinans,* presumably due to collapse. Hughes & Pirozynski (1973) and Ellis (1976) did not observe attached conidia or conidiogenous cells in the specimen of *T. inquinans* they studied. Hughes & Pirozynski (1973) assumed that the conidia of *T. inquinans* develop singly from swollen hyphal tips (subglobose conidiogenous cells?) that either collapse after or rupture during conidial secession.

Triadelphia acericola morphologically resembles *T. heterospora*, *T. inquinans*, and *T. diversa* in having 2-septate, cylindrical, form (a) conidia. *Triadelphia heterospora* differs by its much larger form (a) conidia (16.2–19.0 × 3.5–6.0 μm; Shearer & Crane 1971) and the absence of form (b); *T. diversa* form (a) conidia differ in their colorless basal cells (Tzean & Chen 1989); and *T. inquinans* form (a) conidia differ by the absence of any dark band covering the apical conidial septum (Hughes & Pirozynski 1973).

Fig. 1—*Triadelphia acericola* (holotype, BPI 893194). A. form (a) cylindrical conidia; B, C. form (b) oblong and ellipsoidal conidia; D. form (d) clavate conidia [arrow indicates collapsed terminal cell]; E. form (a) conidia with form (b) conidia [arrowed]; F. form (f) globose conidium; G. form (a) conidia with form (f) conidium [arrowed]; H. conidiogenous cells. Scale bars = 5 μm.


A
B
C
D
H
E
F
G

Despite several attempts to isolate this fungus onto cultural media, the fungus failed to grow on either MEA or CMA, suggesting that the fungus on the specimen may have lost its viability. Failure to isolate this fungus prevented us from obtaining DNA sequences and carrying out phylogenetic studies.

Triadelphia alabamensis (Matsush.) Constant. & Samson, Mycotaxon 15: 482. 1982 FIG. 2B

≡ *Stemphyliomma alabamensis* Matsush., Matsush. Mycol. Mem. 2: 16. 1981.

≡ *Pithomyces alabamensis* (Matsush.) P.M. Kirk, Trans. Br. Mycol. Soc. 80(3): 462. 1983.

This species develops two different conidial forms: form (d) fusiform or ellipsoidal, 6–8-septate, 28–44 × 10.5–16 µm; end cells colorless or pale brown, central cells pale brown to brown, dark band covering over the central septum; form (e) cylindrical, pale olivaceous, 1–3-septate (mostly 1-septate), smooth, curved, guttulate, with rounded ends, 14–28 × 4.5–5.5 µm.

HABITAT/HOST: On slime flux from wood of *Quercus.*

DISTRIBUTION: USA (Alabama).

Pithomyces alabamensis is now accepted as the current name of this species (MycoBank 2017, Species Fungorum 2017). Although its form (e) conidia do exhibit the rhexolytic secession of *Pithomyces,* its pleomorphic nature makes *Triadelphia* a better fit.

Triadelphia archontophoenicicola D.W. Li, **nom. nov.** FIG. 2C

MYCOBANK MB 813055

≡ *Triadelphia australiensis* Joanne E. Taylor, K.D. Hyde & E.B.G. Jones, Fungal Diversity Res. Ser. 12: 366. 2003, nom. illeg. (non B. Sutton 1989).

ETYMOLOGY: after the genus of *Archontophoenix alexandrae* (F. Muell.) H. Wendl. & Drude (*Arecaceae*) on which the type was collected.

A replacement name (nom. nov.) is required because *T. australiensis* Joanne E. Taylor et al. is an illegitimate later homonym of *T. australiensis* B. Sutton (McNeill et al. 2012: Art. 53.1).

This fungus develops five conidial forms and two types of conidiophores. Type 1 conidiophores are micronematous, cylindrical, flask-shaped, 18–30 × 8–12.4 µm, pale to dark brown, 1–3-septate; they bear form (d) conidia, obclavate, 104–132 × 19–24 µm, dark brown to black, abruptly becoming colorless at the long narrow apex, 5–9 µm wide, smooth, 10–13 septa, septa in dark part covered in dark bands. Type 2 conidiophores are semi-macronematous, cylindrical, 60–190 × 4–6 µm, dark red-brown, 4–8-septate; they develop form (a) conidia, cylindrical to fusiform, 24–35 ×

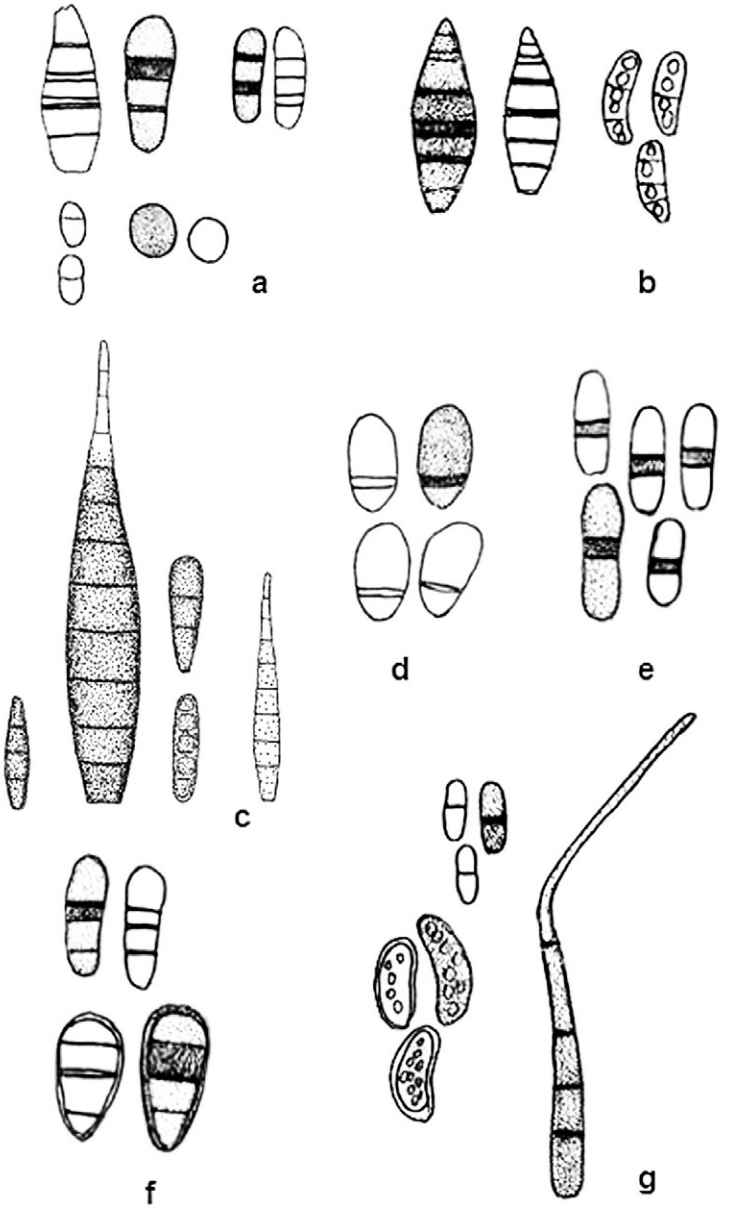


Fig. 2—Conidial forms produced by 7 *Triadelphia* spp.: a. *T. acericola*; b. *T. alabamensis*; c. *T. archontophoenicicola*; d. *T. australiensis* B. Sutton; e. *T. centroseptata*; f. *T. corticola*; g. *T. disseminata*. Line drawings by Rafael F. Castañeda-Ruiz.

6–9 µm, brown, 1–3-septate covered by narrow dark bands, smooth, with a conspicuous dark hilum, with or without a small mucilaginous appendage at the acute apex. In addition, conidial forms (b), (c), and (g) are associated with both conidiophore types: form (b) conidia, clavate, 24–26 × 8–11 µm, brown, 1–3-septate covered by dark bands, smooth, guttulate; form (c) conidia, acicular with a long colorless apex, 44 × 6 µm, pale yellow-brown, approximately 8-septate, smooth, acute apex, guttulate; and form (g) conidia, ellipsoidal to cylindrical, 18 × 6 µm, pale brown, straight or curved, smooth, 4-pseudoseptate, obtuse apex and base, guttulate (Taylor & Hyde 2003).

Habitat/host: on a dead rachis of *Archontophoenix alexandrae*.

Distribution: Australia.

This is a species with some features that are unique in the genus; it is the only species that develops two kinds of conidiophores, and it produces pseudoseptate form (g) conidia that do not correspond with any of the conidial forms categorized by Constantinescu & Samson (1982). Taylor and Hyde (2003) considered that these pseudoseptate conidia represented a new conidial form for the genus when they assigned their new species to *Triadelphia*. Further studies on this species are needed to determine its phylogenetic relationship with other members of *Triadelphia* and allied genera.

Triadelphia australiensis B. Sutton, Sydowia 41: 339. 1989 Fig. 2d

This species develops only form (b) conidia, 8.5–10 × 4.5–6 µm (Sutton 1989), apical, solitary, dry, ellipsoidal, obovoid to broadly obovoid, smooth, thick-walled, 1-septate near the base, thickened, some constricted at the septum.

Habitats/hosts: bark, submerged wood, water damaged plywood from a rink, and dry wall indoors (Li et al. 2013).

Distribution: Australia, Canada, Hong Kong, USA.

Triadelphia australiensis is morphologically very similar to *T. uniseptata.* The difference is that *T. australiensis* B. Sutton has smaller conidia than *T. uniseptata,* which are larger (12.5–16 × 6.5–10.5 µm; Kirk 1983). Ranghoo & Hyde (1998) identified *Trichocladium uniseptatum* [≡ *Triadelphia uniseptata*] as the anamorph of their new genus and species, *Ascolacicola aquatica* Ranghoo & K.D. Hyde, but their conidial measurements (6.5–10 × 3.8–6.3 µm) match *T. australiensis*, rather than *T. uniseptata*. Moreover, Réblová (2013) designated this anamorph as merely "*Triadelphia*-like."

Triadelphia centroseptata Venkateshw., S.M. Reddy & S.R. Reddy ex D.W. Li, **sp. nov.** Fig. 2e

MycoBank MB 823119

"*Triadelphia centroseptata*" Venkateshw., S.M. Reddy & S.R. Reddy, Indian Phytopath. 49(4): 340. 1997 ["1996"], nom. inval. (ICN Arts 40.1, 40.6, 40.7).

Type: India, Andhra Pradesh, Warangal, Daharmassagar Village, on dead rachis of *Cocos nucifera* L. (*Arecaceae*), 22 Nov 1989 (**Holotype**, IMI 300593; **isotype**, KUMH HM50).

The species was invalidly published by Venkateshwarlu et al. (1997), because they presented two herbarium accessions (IMI 300593; KUMH HM50) but failed to nominate either of them as a type, failed to include the word "type" or an equivalent, and failed to nominate a single herbarium where the holotype was conserved (McNeill et al. 2012: Art. 40). Here we validate the species by designating IMI 30059 as its holotype.

One conidial form (a): cylindrical, 12.5–21 × 4–8.5 µm, brown, 1-septate, septum covered in a wide dark band, smooth.

Habitat/host: On dead rachis of *Cocos nucifera* L.

Distribution: India

Note—*Triadelphia centroseptata* is described and illustrated in detail by Venkateshwarlu et al. (1997). The type material of this species should be closely examined in the future to determine whether it truly develops only one form of conidia. Its conidia resemble those of *T. inquinans*. However, the latter species produces smaller cylindrical conidia (a) as well as four other conidial forms.

Triadelphia corticola Manohar., N.K. Rao & D.K. Agarwal, J. Mycopathol. Res. 39: 109. 2001. Fig. 2f

Manoharachary et al. (2001) identified two conidial forms: form (a) as narrowly cylindrical rounded at the apex, smooth, 18–21 × 4.5–5.2 µm, 2-septate, distal septum covered by a wide dark band, basal one narrow, dark brown; and form (b) as larger, ovoid, smooth, rounded at the apex, 2-septate, distal septum covered by a wide brownish to black band, 18–21 × 7–8.3 µm. However, based on the type illustration and conidial secession of the fungus, it appears that these two conidial "forms" represent a single conidial form that vary in conidial width, both of which we refer to in our key as form (a).

Habitat/host: on bark of an unidentified plant.

Distribution: India.

Triadelphia corticola is morphologically similar to *T. hungarica* in conidial size and shape. But, *T. hungarica* develops another conidial form with 6–7 septa (Révay 1987).

Triadelphia disseminata Madrid & J. Edathodu, Persoonia 34: 235. 2015. Fig. 2g

This is the second species isolated from human beings (Madrid et al. 2015). It develops three types of conidia in culture: form (a) (sub) cylindrical with obtuse ends, pale to dark brown, smooth, thick-walled, with 1 septum situated above the middle (occasionally 1-celled), often slightly constricted at the septum, 5–11 × 2.5–4 µm; form (c) obclavate to acicular, straight to slightly curved, colorless to pale olivaceous brown, smooth, thin-walled, 3–4-septate, 43–227 × 3–4 µm, with a truncate base and a cylindrical body gradually tapering into a long beak with an obtuse end; and form (e) reniform to allantoid, colorless to light brown, smooth, thin-walled, 1-celled, with obtuse ends, 5.5–11.5 × 2–3.5 µm (Madrid et al. 2015).

Habitat/host: from a disseminated infection in an immuno-compromised patient.

Distribution: Saudi Arabia.

Triadelphia disseminata is morphologically similar to *T. pulvinata* The conidial form (c) of *T. disseminata* are 3–4-septate, while in *T. pulvinata* 5–7 septate (Maggi et al. 1978).

Triadelphia diversa Tzean & J.L. Chen, Mycologia 81: 630. 1989. Fig. 3a

This species develops five conidial forms: form (a), cylindrical, straight or slightly curved, 13.7–24 × 4–8 µm, 1–2-septate; septa covered with wide dark bands; wall smooth; apical and central cells brown, basal cell colorless or pale brown; form (b), broadly clavate, 11.5–15.3 × 6.3–8 µm, with one transverse septum near the base, covered with a dark band; smooth; apical cell brown, basal cell colorless or pale brown, with truncate base; form (d), obclavate, 4–6-septate, 15–26 × 6–7 µm; end cells colorless to pale brown, acicular, basal cells subhyaline to pale brown, truncate, central cells pale brown to brown, often with dark bands at the septa; form (e), allantoid or reniform, colorless or pale brown, 2 celled, smooth, thin-walled, 8–16 × 3–5 µm; and form (f), obovate, pale brown, 1-celled, smooth, 5.9–9.8 × 4.3–5.6 µm with a truncate base (Tzean & Chen 1989).

Habitat/host: rotten fallen stem of angiosperm.

Distribution: Taiwan.

Triadelphia diversa is morphologically similar to *T. acericola*, *T. heterospora*, and *T. inquinans*. *Triadelphia diversa* does not develop conidial form (c); *T. acericola* does not have conidial forms (c) and (e); *T. heterospora* has no

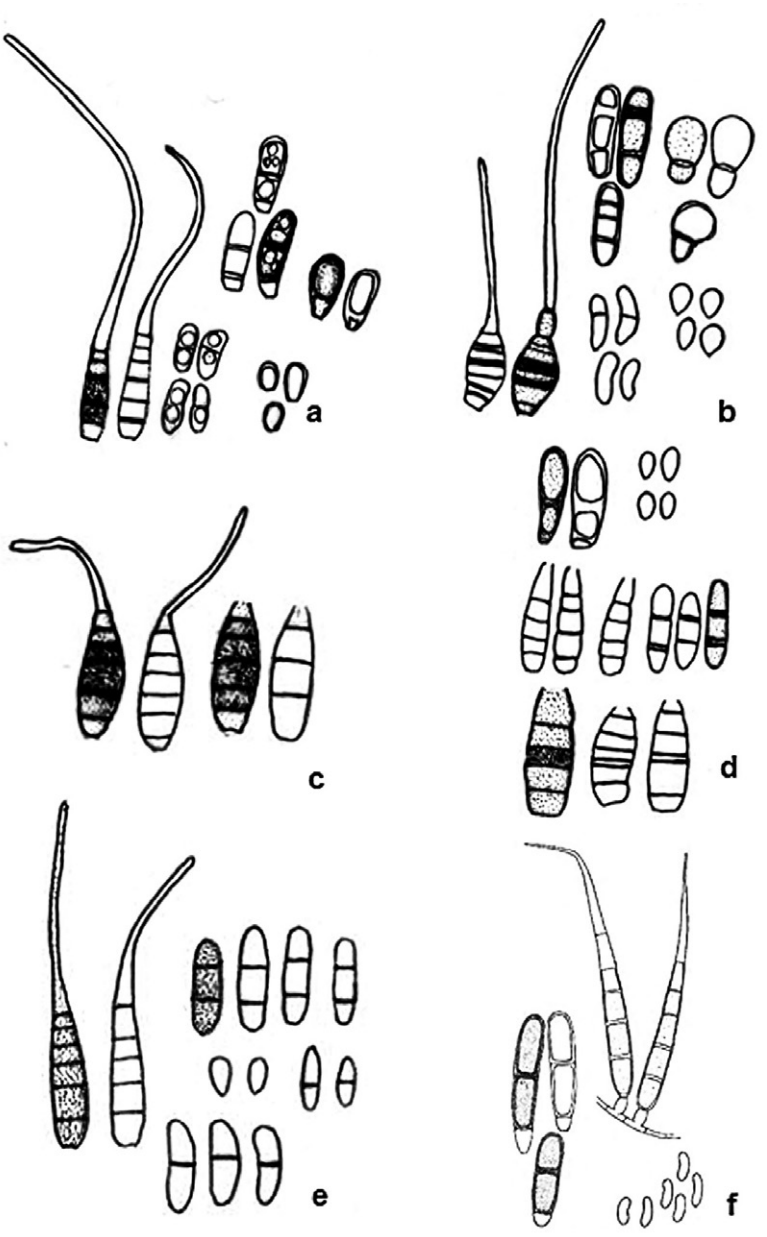


Fig. 3— Conidial forms produced by 6 *Triadelphia* spp.: a. *T. diversa*; b. *T. heterospora*; c. *T. hungarica*; d. *T. inquinans*; e. *T. loudetiae*; f. *T. morgoensis*. Line drawings a–e by Rafael F. Castañeda-Ruiz; line drawing f from Révay (1993), redrawn by the authors.

conidial forms (b) and (c) (Shearer & Crane 1971) and *T. inquinans*, no conidial form (e) (Hughes & Pirozynski 1973).

Triadelphia heterospora Shearer & J.L. Crane, Mycologia 63: 247. 1971. Fig. 3B

This is the type species of the genus *Triadelphia*. Shearer & Crane (1971) originally described *T. heterospora* as having two conidial forms: form (a), cylindrical, 2-septate, rounded at the apex, rounded to slightly truncate at base, brown, smooth, thick-walled, (14.7–)16.2–19.0(–21.2) × 3.5–6.0 μm, the apical septum covered by a black band and form (d), broad ellipsoid, 4–7-septate, 17.6–23.5 × 8.2–10.6 μm, end cells colorless to subhyaline, central cells subhyaline, brown to very dark brown often with black bands at the septa. After examination of the type material, Constantinescu & Samson (1982) described two additional conidial forms for this species: form (e), allantoid or reniform, colorless or pale brown, 0–1 septate, smooth, thin-walled, rounded at both ends, 8.5–15 × 3–5 μm and form (f), obovate to ellipsoidal, pale brown, 1-celled, smooth, thin-walled, 6–8 × 4–5 μm. However, their illustrations clearly showed that form (f) conidia were thick-walled. Shearer & Crane (1971) included "form (e)" conidia among cylindrical form (a) conidia in their illustration; it appears that they considered "form (e)" conidia to be merely immature cylindrical form (a) conidia.

Habitats/hosts: balsa wood block submerged in fresh water, pine block submerged in sea water in the air, rain water, litter of *Mentha aquatic* L. and *Mentha* ×*rotundifolia* (L.) Huds. from wetland, and debris from a tree-hollow (Czeczuga et al. 2007, Gönczöl & Révay 2004, Révay 1987). This is an aquatic fungus, but it has also been found in the air of an orchid greenhouse (Magyar et al. 2011), and its cylindrical conidia were found in the air indoors in the USA (pers. obs.).

Distribution: Cuba, Hong Kong, Hungary, India, Jamaica, Pakistan, Poland, USA.

Triadelphia heterospora is morphologically similar to *T. acericola*, *T. inquinans*, and *T. diversa*. *Triadelphia heterospora* does not develop conidial forms (b) and (c) (Shearer & Crane 1971); *T. acericola* does not have conidial forms (c) and (e); and *T. inquinans*, no conidial form (e) (Hughes & Pirozynski 1973); *T. diversa* does not develop conidial form (c) (Tzean & Chen 1989).

Triadelphia hungarica Révay, Acta Bot. Hung. 33: 68. 1987. Fig. 3C

This species develops two conidial forms: form (a), clavate or slightly cylindrical, dark brown, 2-septate with apical septum covered by a dark band,

17.6–20.8 × 6.4–7 µm and form (b), fusiform-ellipsoidal, straight or slightly curved, 6–7-septate, with a dark band in the middle, truncate at the base, 32–36 × 8–10 µm, central cells pale brown to dark brown (Révay 1987).

Habitat/host: on debris of ?*Quercus*.

Distribution: Hungary

Triadelphia inquinans (Sacc.) S. Hughes & Piroz.,
Can. J. Bot. 50: 2524. 1973 ["1972"]. Fig. 3d
≡ *Dicoccum inquinans* Sacc., Michelia 1(2): 264. 1878.

This species develops five conidial forms. Saccardo (1878) originally described only one type of conidia: form (b), cylindrical-clavate, 16–20 × 4–5 µm, 1-septate at middle, with rounded apex and truncate base. Hughes & Pirozynski (1973) and Ellis (1976) described form (b) and form (d) conidia.

Hughes & Pirozynski (1973) re-described this species based on their study of three specimens including the type. They described two conidial forms: form (b) conidia, shorter than those of the type, clavate, with thin-walled frill (part of conidiogenous cell?), 12–18 × 4–6 µm and form (d) conidia, broadly ellipsoidal, usually curved, 15–18 × 8–9 µm, possibly 5-septate (incomplete), the two middle cells thick-walled, dark brown with the median septum covered by a dark chestnut-brown band, the penultimate cells paler, and the end cells colorless to subhyaline.

Constantinescu & Samson (1982) studied the type material and described three additional conidial forms: form (a), cylindrical, (1–)2-septate, pale brown, smooth, 12–16 × 3–4 µm; form (c), obclavate, 3–5-septate, yellowing brown, smooth, thin-walled, tip not observed, the base truncate, 13–23 (incomplete) × 4–5 µm; and form (f), obovate to large ellipsoidal, pale brown, 1-celled, pale brown, smooth, thin-walled, 4–5 × 2.5–3 µm. However, the illustration of Constantinescu & Samson (1982) depict form (f) conidia as thick-, not thin-, walled; and form (d) conidia as larger (17–24 × 7–9 µm, [incomplete]) than those of Hughes & Pirozynski (1973).

Habitat/host: decayed inner bark of *Populus nigra* var. *italica* Münchh., *Populus* sp.

Distribution: Italy.

Triadelphia loudetiae Maggi, Bartoli & Rambelli,
Trans. Br. Mycol. Soc. 71: 150. 1978. Fig. 3e

Maggi et al. (1978) described only the predominant form (a) conidia: cylindrical, dark brown, 2-septate, rounded at both ends, smooth, a basal pore visible, 12–18 × 4.5–5 pm. Constantinescu & Samson (1982) included two

additional forms: form (c), obclavate, yellowish brown, sometimes slightly constricted at septa, smooth, thin-walled, 5–6-septate, 30–105 × 4–5 µm, gradually tapering into a long colorless beak and form (e), allantoid, reniform or nearly cylindrical, colorless or subhyaline, 0–1-septate, smooth, thin-walled, 7–12.5 × 2–3.5 µm.

Habitat/host: from rhizosphere of *Loudetia simplex* (Nees) C.E. Hubb.

Distribution: Ivory Coast.

Triadelphia morgoensis Révay, Stud. Bot. Hung. 23: 63. 1993 ["1992"]. Fig. 3f

This species develops three conidial forms: form (a), cylindrical, straight or slightly curved, 2-septate, thick-walled, with a rounded apex and a truncate base, 16–25.6 × 3.2–4.8 µm; form (c), obclavate, subhyaline, 5–7-septate, base truncate, gradually tapering into a long beak, 40–57.6 × 3.2–4 µm; and form (e), allantoid or reniform, colorless, one-celled, smooth, thin-walled, 4.8–6 × 2–3 µm (Révay 1993).

Habitat/Host: on rotten wood.

Distribution: Hungary.

Triadelphia morgoensis differs from *T. diversa* by the absence of conidial forms (b), (d), and (f), by its narrower form (a) conidia having wide dark bands covering their septa (cf. *T. diversa* form (a) conidia, 13.7–24 × 4–8 µm, without dark bands), and by its 0-septate form (e) conidia (cf. 1-septate in *T. diversa*).

Triadelphia pulvinata Maggi, Bartoli & Rambelli,
Trans. Br. Mycol. Soc. 71: 150. 1978. Fig. 4a

Maggi et al. (1978) described the predominant form (a) conidia as solitary, cylindrical, deep brown, 1-septate, rounded at both ends, with distinct and smooth wall, basal pore not easily seen, 11.5 × 4 pm. Constantinescu & Samson (1982) described all three conidial forms for this species: form (a), cylindrical, pale brown, 1-septate, rounded at both ends, smooth, wall 0.3 µm thick, 9–12 × 3–3.4 µm; form (c), acicular to obclavate, colorless, slightly curved, smooth, thin-walled, 5–7 septate, 40–160 × 3–4 µm, gradually tapering into a long tail with rounded apex and truncate base; and form (e), allantoid or reniform, colorless or pale brown, 1-celled, smooth, thin-walled, rounded at both ends, 6–9.5 × 2–3 µm. Some conidia are mostly clavate, asymmetrical, dark brown, larger, 9–13 × 4.5–6 µm; Constantinescu & Samson (1982) considered these to represent over-mature form (e) conidia.

Habitats/Hosts: from rhizosphere of *Loudetia simplex*, dead rachides of *Phoenix canariensis* Chabaud (von Arx 1985), and a human eyelid infection.

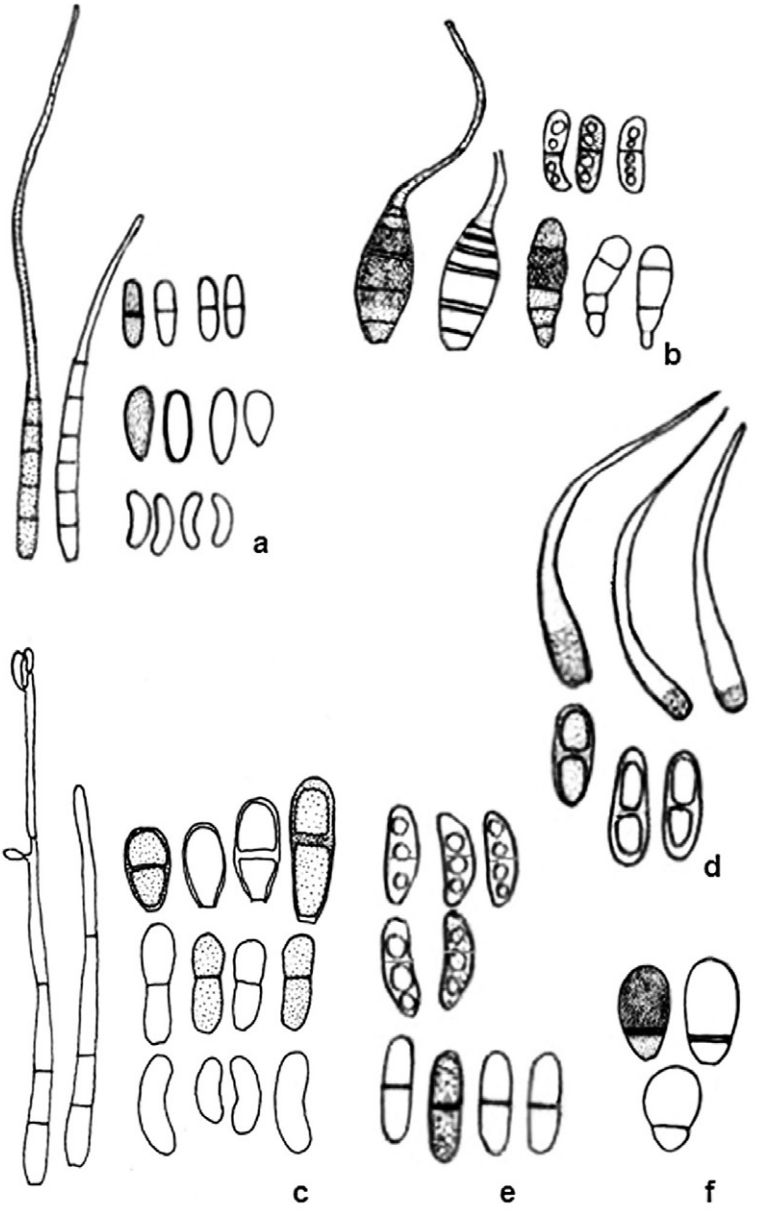


Fig. 4— Conidial forms produced by 6 *Triadelphia* spp.: a. *T. pulvinata*; b. *T. queenslandica*; c. *T. romanica*; d. *T. stilboidea*; e. *T. synnematofera*; f. *T. uniseptata*. Line drawings by Rafael F. Castañeda-Ruiz.

Triadelphia pulvinata is a soil hyphomycete that was reported to cause eczematoid, scaly, grey lesions on the skin of both eyelids of a male patient in Saudi Arabia (Al-Hedaithy 2001).

Distribution: Canary Islands, Ivory Coast, Saudi Arabia.

Triadelphia pulvinata was originally described with the conidia and conidiogenous cells developing on ropes of brown hyphae. This raises questions of whether these hyphal ropes are premature stages of synnemata or whether this species is intermediate between synnematous and semi-macronematous members of the genus. Further studies on this species are necessary.

T. pulvinata is morphologically similar to *T. romanica, T. stilboidea,* and *T. synnematofera*. Both *T. stilboidea*, and *T. synnematofera* develop synnemata (Mercado Sierra & Castañeda 1983, Matsushima 1995), while *T. pulvinata* and *T. romanica* do not. *Triadelphia pulvinata* does not develop conidial forms (b) and (d) (Maggi et al. 1978), while *T. romanica* has no conidial form (d) (Constantinescu & Samson 1982).

Triadelphia queenslandica Matsush., Matsush. Mycol. Mem. 6: 42. 1989. Fig. 4b

This species develops three forms of conidia: form (b), clavate, 1–3-septate, 15–30 × 8–13 µm, apical cells; brown, paler towards the basal cell; form (d), fusiform, apices frequently filiform, conidia without apical portion 30–42 × 12–18 µm, 5–6-septate, central cells brown black, paler towards both ends, apical cell about 400 µm long, filiform, 0-septate, colorless, often collapsed at maturity; and form (e), allantoid to reniform, mostly 1-septate, rarely 2-septate, 16–25 × 5–8 µm, pale brown (Matsushima 1989).

Habitat/host: on rotten leaf of *Musa* ×*sapientum* L.

Distribution: Australia (Matsushima 1989, Photita et al. 2002)

Triadelphia queenslandica, which is morphologically similar to *T. heterospora* and *T. hungarica,* does not develop conidial forms (a) & (c), while *T. heterospora* lacks conidial forms (b) & (c) and *T. hungarica* does not develop conidial forms c–f. The conidial form (b) of *T. queenslandica* does resemble the chlamydospores produced by aerial mycelia of *Trichocladium opacum* (Corda) S. Hughes (Kendrick and Bhatt 1966, Matsushima 1989). However, conidial forms (d) & (e) of *T. queenslandica* separate it from *Tric. opacum*.

Triadelphia romanica Constant. & Samson, Mycotaxon 15: 482. 1982. Fig. 4c

This species develops four forms of conidia: form (a), cylindrical, 0–1-septate, constricted in the middle, pale brown, smooth, 6.5–14 × 2.5–4 µm; form (b), clavate, brown, smooth, thick-walled (0.5–0.8 µm thick), 1-septate, 13–22 ×

5.5–5 µm; form (c), obclavate to acicular, colorless, smooth, thin-walled, 2–4-septate, 50–80 × 3–4.5 µm, base truncate, gradually tapering into a long beak of 1–1.5 µm wide; and form (e), allantoid to reniform, colorless, 1-celled, thin-walled, smooth, rounded at both ends, 7–12 × 2–3 µm (Constantinescu & Samson 1982).

Habitats/hosts: Isolated from avian eggshell; decayed frond of *Palmae* (Matsushima 2001).

Distribution: Peru, Romania.

Triadelphia romanica is morphologically similar to *T. pulvinata*. *Triadelphia romanica* does not develop conidial form (d) (Constantinescu & Samson 1982), while. *T. pulvinata* has no conidial forms (b) and (d) (Maggi et al. 1978).

Triadelphia stilboidea Mercado & R.F. Castañeda,
Revista Jard. Bot. Nac., Univ. Habana 4(2): 68. 1983. Fig. 4d

This species has synnematous conidiophores, tretic conidiogenous cells, and two conidial forms; form (a) predominating: cylindrical, sometimes ellipsoidal or obclavate, olivaceous or brown olivaceous, 1-septate, rarely 0-septate, 7.5–15 × 2.4–4.7 µm; and form (?c), seta-like, very long, obclavate, rostrate, 1-celled, dark brown at the base, becoming paler towards apex, subhyaline at apex, 20–85 × 3.5–4.7 µm, tapering to 0.7–1 µm at apices. The seta-like conidia of this species do not fit any forms categorized by Constantinescu & Samson (1982).

Habitats/hosts: decayed leaf of unknown palm; dead leaf petiole of *Roystonea regia* (Kunth) O.F. Cook.

Distribution: Cuba, Puerto Rico.

Révay (1993), who considered *T. stilboidea* not closely related to *T. heterospora* and other species of *Triadelphia*, excluded it from *Triadelphia*.

Matsushima (1995) considered that the synnematous *Triadelphia stilboidea* has setae similar to those of *Trichurus spiralis* Hasselbr., not setae-like conidia as described by Mercado Sierra & Castañeda (1983).

Triadelphia stilboidea and *T. synnematofera* both develop synnemata (Mercado Sierra & Castañeda 1983, Matsushima 1995). *Triadelphia stilboidea* develops conidial forms (a) and (c) (Mercado Sierra & Castañeda 1983), while *T. synnematofera* has conidial form (a) and (e) (Matsushima 1995).

Triadelphia synnematofera Matsush.,
Matsush. Mycol. Mem. 8: 38. 1995, as "*synnematfera*" Fig. 4e

Synnemata solitary, gregarious, cylindrical, 210–350 µm in height. Conidia of two forms: form (a) cylindric-ellipsoidal, 1-septate, smooth, dark brown,

9–17 × 3.5–5 µm and form (e) allantoid, reniform or cylindrical, 1-septate, straight or slightly curved, smooth, colorless, 11–16 × 4–5.5 µm (Matsushima 1995).

Habitat/Host: on decayed petiole of palm

Distribution: Peru.

Triadelphia synnematofera is another synnematous species with two conidial forms. Its form (a) conidia that are 1-septate and have no dark band over the septum easily distinguish it from *T. stilboidea*.

Triadelphia uniseptata (Berk. & Broome) P.M. Kirk,
Trans. Br. Mycol. Soc. 80: 464. 1983. Fig. 4f

≡ *Sporidesmium uniseptatum* Berk. & Broome, Ann. Mag. Nat. Hist., Ser. 3, 3: 360. 1859.

≡ *Trichocladium uniseptatum* (Berk. & Broome) S. Hughes & Piroz., Can. J. Bot. 50(12): 2526. 1973 ["1972"].

= *Dicoccum apiosporum* Sacc., Nuovo G. Bot. Ital. 22: 71. 1915 (Hughes & Pirozynski 1972).

= *Polyschema bicellulare* Shearer, Mycotaxon 14(1): 91. 1982 (Kirk 1983).

This is another species that develops only one conidial form, form (e), obovoid, 1-septate, smooth, brown, apical cell much larger than the basal cell. *Triadelphia uniseptata* is morphologically similar to *T. australiensis* B. Sutton, but differs in its larger conidia, 12.5–16 × 6.5–10.5 µm (Kirk 1983).

Habitats/hosts: on dead wood, submerged wood, stems, or twigs; debris from a tree hollow, on bark of *Clematis vitalba* L., bark of *Melicoccus bijugatus* Jacq., dead bark of *Quercus rubra* L., cones of *Pinus halepensis* Mill., rotting wood of *Hedycarya arborea* J.R. Forst. & G. Forst., stem of *Rubus plicatus* Weihe & Nees, on twigs of *Platanus occidentalis* L., softwood label in greenhouse, dust from indoor environments, rain water (Berkeley & Broome 1859, Hughes & Pirozynski 1973, Kirk 1983, Matsushima 1987, Révay 1987).

Distribution: Canada, Cuba, France, Hong Kong, Hungary, India, Malta, New Zealand, UK, United States.

Key to species of *Triadelphia*

1. Conidia only one form and not synnematous 2
1. Conidia pleomorphic (2–5 forms) or synnematous 5
2. Conidia 1-septate 3
2. Conidia 2-septate, cylindrical or clavate, smooth, 18–21 × 4.5–8.3 µm ... *T. corticola*
3. Conidia 1-septate near the base, thickened, sometimes constricted at the septum, ellipsoidal, to broadly obovoid, smooth 4
3. Conidia 1-septate at middle, cylindrical, 12.5–21 × 4–8.5 µm ..... *T. centroseptata*

4. Conidia 8.5–10 × 4.5–6 µm ..... *T. australiensis* B. Sutton
4. Conidia 12.5–16 × 6.5–10.5 µm ..... *T. uniseptata*

5. Synnemata present 6
5. Synnemata absent 7

6. Conidia of 2 forms: one cylindrical and 1-septate; the other seta-like ... *T. stilboidea*
6. Conidia of 1 form: cylindrical and 1-septate ..... *T. synnematofera*

7. At least one conidial form is broadly obclavate, fusiform ellipsoidal, with black band at the septa 8
7. Not as above 16

8. Conidia fusiform-ellipsoidal, without acerose end cells ..... *T. alabamensis*
8. Conidia broadly obclavate or fusiform-ellipsoidal with acerose end cells 9

9. Cylindrical conidia absent 10
9. Cylindrical conidia present 12

10. Conidiophores of two types with 5 conidial forms ..... *T. archontophoenicicola*
10. Not as above 11

11. Conidia fusiform-ellipsoidal, 32–36 × 8–10 µm ..... *T. hungarica*
11. Conidia fusiform, 30–42 × 12–18 µm ..... *T. queenslandica*

12. Allantoid or reniform conidia absent 13
12. Allantoid or reniform conidia present 14

13. Cylindrical form (a) conidia 2-septate, apical septum covered with a dark band, 13.4–15.8 × 4.2–5.4 µm ..... *T. acericola*
13. Cylindrical form (a) conidia (1–)2-septate without dark band, pale brown, smooth, 12–16 × 3–4 µm ..... *T. inquinans*

14. Clavate conidia absent 15
14. Clavate conidia present, cylindrical form (a) conidia 13.7–24 × 4–8 µm, 1–2-septate; septa covered with dark 2 µm bands, with a colorless base cell *T. diversa*

15. (Sub)cylindrical form (a) conidia 1-septate, 5–11 × 2.5–4 µm ..... *T. disseminata*
15. Cylindrical form (a) conidia 16.2–19.0 × 3.5–6.0 µm, 2-septate, the apical septum covered by a black band ..... *T. heterospora*

16. Cylindrical form (a) conidia 1-septate 17
16. Cylindrical form (a) conidia 2-septate 18

17. Cylindrical conidia 6.5–14 × 2.5–4 µm; clavate conidia present ..... *T. romanica*
17. Cylindrical conidia 9–12 × 3–3.5 µm; clavate conidia absent ..... *T. pulvinata*

18. Cylindrical conidia brownish, 9–19 × 3–5 µm; reniform conidia 1-septate ..... *T. loudetiae*
18. Cells of the cylindrical conidia differently pigmented, 16–25.6 × 3.2–4.8 µm; reniform conidia 0-septate ..... *T. morgoensis*

Discussion

Ranghoo & Hyde (1998) reported that *Ascolacicola aquatica* had *T. uniseptata* as its anamorphic state; however, the conidial size that they reported (6.5–10 × 3.8–6.3 µm) corresponds with *T. australiensis* B. Sutton rather than *T. uniseptata*, and Réblová (2013) designated the anamorph as merely "*Triadelphia*-like". *Platytrachelon abietis* (Réblová) Réblová also develops two forms of anamorphs morphologically similar to the *Triadelphia*-like anamorph of *Ascolacicola aquatica* (Réblová 2013). Réblová & Seifert analyzed nc28S sequences of *Triadelphia uniseptata* from Canada and *Platytrachelon abietis*; no close relationship was confirmed, and the molecular data placed *T. uniseptata* in the *Hypocreomycetidae*, *Sordariomycetes* (Réblová & Seifert unpubl.).

These results suggest that *Triadelphia* is polyphyletic and its systematic placement remains unknown. Further phylogenetic studies are necessary.

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